A Comparative Study of Proactive and Reactive Routing Protocols in Mobile Ad hoc Networks

C. Satya Kumar[#1], V. Srinivas[*2]

[#1]*Associate Professor, Computer Science and Engineering, Vardhaman College of Engineering, India*
[1]*c.satyakumar@vardhaman.org*

[*] *Associate Professor, Computer Science and Engineering, Aurora's Scientific Technology & Research Academy, India*
[2]*srinivassai1549@gmail.com*

Abstract: Mobile Ad hoc networks (MANET) – it is a collection of wireless mobile nodes communicating each without infrastructure support i.e. MANET is an infrastructure less network. Due to infrastructure less capability uses of mobile ad hoc networks (MANET) in different applications increasing rapidly. There are different challenges where most of the research is going on bandwidth consideration, power consumption, scalability, routing and security. This paper mainly focuses on routing protocols which is the important challenging issue because of dynamic topology of ad hoc networks.

***KEY WORDS*—MOBILE AD HOC NETWORKS, ROUTING PROTOCOLS COMPARISON.**

I. INTRODUCTION

Mobile ad hoc network (MANET) is an autonomous group of wireless mobile nodes (smart phones, laptops etc.); in which nodes communicate by transmitting packets each other. MANET does not require any centralized administration or fixed infrastructure support. MANET is an infrastructure less network. Easily deployable within the environment and used in applications like military operations, rescue operations, emergency services and business meetings. MANET is self-organizing wireless network having limited bandwidth, unreliable links, and dynamic topology (due to mobility of nodes) which requires efficient routing algorithms. Following figure 1 shows a mobile ad hoc network.

1. A mobile ad hoc network

Outline of the paper:

The paper is formulated as follows: Section II gives description of routing in MANETs. Section III describes classification of various routing protocols. Section IV presents Proactive routing protocols. Section V presents Reactive routing protocols. Finally Section VI concludes the paper.

II. ROUTING IN MANETS

An easy way to comply with the journal paper formatting requirements is to use this document as a template and simply type your text into it. A Mobile ad hoc network is a collection mobile nodes can transmit packets only to the nodes within the range and use intermediate nodes to transmit packets which are not in the range is called multi-hop technique. In MANETS nodes act as not only as a host also as a router. Due to mobility of a node topology of a network changes dynamically so we required routing protocols so that it takes efficient route to forward packet from source to destination. There are three types of routing protocols: Proactive routing, Reactive routing and Hybrid routing. Proactive routing is also called table driven routing in which each node in the MANET will have complete information about other nodes in table format to transmit packets from source to destination and this table updated periodically. Reactive routing is also called on-demand routing in which route established when a node wants to transmit packet from source to destination using route request and route reply services. Hybrid Routing is a mixture of Proactive routing and Reactive routing.

III. CLASSIFICATION OF VARIOUS ROUTING PROTOCOLS

We will discuss division of ad hoc routing protocols, their characteristics features and types. Based on the routing information updated routing protocols for ad hoc wireless networks can be classified into three categories. They could be Proactive also called Table-driven, Reactive also called on-demand, and Hybrid. Figure 2 shows classification of three ad hoc routing protocols and various suggested protocols under each category [1, 2, 3].

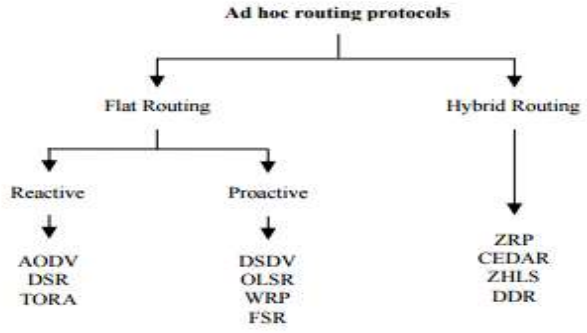


Fig.2. Classification of various routing protocols

IV. PROACTIVE ROUTING PROTOCOL:

In this protocol each node maintains route information to every other node in the network. To maintain route information at each this requires one or more route tables. These tables updated periodically but when there is change in network topology it's reflected in the route table. These types of protocols differ in routing updated, detected and type of information maintained in each node. In this section we consider some examples of table driven ad hoc routing protocols that include Dynamic Destination Sequenced Distance-Vector Routing Protocol short form DSDV [4], Optimized Link State Routing Protocol short form OLSR [5] and Wireless Routing Protocol short form WRP [6]. These protocols actually differ in the number of routing related tables and how the changes are broadcasted in the network structure.

i) *Destination Sequenced Distance-Vector Routing Protocol (DSDV):*

DSDV is a modification of Bellman-ford algorithm with a certain improvement such as loop free routes. In this, each node maintains a routing table containing entries for all the nodes in the network and using distance vector shortest path routing algorithm chooses a single path to a destination.. Each node periodically broadcasts routing information to its neighbor to keep routing table updated at all the time. When a node receives a broadcasted message from its neighbor and knows the current link cost to the node, it compares this value and the change in a value reflected in the routing table. DSDV is a simple routing algorithm to implement, but introduces large amounts of overhead to the network because of periodic update of routing tables so large portion of network bandwidth is used for updating routing tables.

ii) *Optimized Link State Routing Protocol (OLSR):*

OLSR routing protocol is an optimized version of a pure link state protocol for mobile ad hoc networks. Because of its proactive nature, it has an advantage of having the routes available immediately when needed. In a pure link state protocol, all links with neighbor nodes are declared and are flooded in the entire network. This is the case not done in OLSR, First it reduce the size of control packets, instead of all links, it declares only a subset of links with its neighbors are its multipoint relay selectors. Secondly, it minimizes flooding of this control traffic by using only the selected nodes, called multipoint relays, to diffuse its messages in the network. Only the multi-point relays of a node retransmit its broadcast messages. This technique significantly reduces the number of retransmissions in a flooding or broadcast procedure.

iii) Wireless Routing Protocol (WRP):

WRP routing protocol is a table-driven protocol like DSDV which inherits the Bellman-Ford algorithm properties. This protocol using predecessor information avoids temporary routing loops and guarantees the loop freedom i.e. WRP is loop free routing protocol. In this protocol each node within the network uses a set of four tables to maintain routing information more accurately: Distance Table (DT), Routing table (RT), Link-cost table (LCT), Message retransmission list table (MRL). This protocol forces each node to perform consistency checks of predecessor information reported by all its neighbors to make a counter to count-to-infinity problem.WRP routing protocol has two disadvantages: 1. at each node it requires four tables to maintain route information accurately. This introduces a significant amount of memory overhead at each node as the network size increases. 2. WRP protocol ensures connectivity between nodes through hello messages. These hello messages are exchanged between neighbor nodes when there is no recent packet transmission. This consumes a significant amount of bandwidth and each node is required to stay active at all times i.e. nodes cannot enter sleep mode to save their power.

iv)Fisheye State Routing Protocol:

FSR [7] is a link state based routing protocol and provides route information immediately by maintaining a topology map at each node. To maintain updated topology map at each node three tasks periodically repeated in this protocol: Neighbor discovery, Information Dissemination and Route computation. Initially every node within the network starts with an empty topology table and an empty neighbor list. By invoking neighbor discovery, it acquires neighbors and maintains current neighbor relationships. By using information dissemination, Link State Packets (LSP) are produced and distributed in the network. Each node in the network has a database consisting of collection of LSPs commenced by each node in the network. Each node uses the route computation and this database to produce a routing table for the protocol. Table 1 shows the comparison few proactive routing protocols.

TABLE 1: COMPARISON OF PROACTIVE ROUTING PROTOCOLS

Parameters	DSDV	WRP	OLSR
Route updates	Periodic	Periodic	Periodic
Loop free	Yes	Yes	Yes
Routing overhead	High	High	Low
Caching overhead	Medium	High	High
Throughput	Low	Low	Medium
Routing tables	2	4	4

V. REACTIVE ROUTING PROTOCOLS:

Reactive protocols also called on-demand routing protocols, because route is discovered from source to destination when a node is required to transmit information. This is not like in proactive routing protocols, where each node maintains a network topology in the table and periodically gets updated, so most of the network bandwidth utilized for maintaining up-to-date network topology in the table . Reactive protocols use bandwidth of a network only during finding a path and transmitting data from source to destination. In reactive protocols route is discovered by flooding a route request (RREQ) packet through the network. When a node is

identified as a destination then route replay (RREP) is sent to the node that generated route request initially using reverse direction. Some examples of source initiated ad hoc routing protocols include the Dynamic Source Routing Protocol (DSR) [8], Ad Hoc On-Demand Distance Vector Routing Protocol (AODV) [9], and Temporally-Ordered Routing Algorithm (TORA) [10].

i) Ad Hoc On-Demand Distance Vector Routing Protocol (AODV):

This routing protocol is an on-demand routing protocol. On-demand means routes are discovered and maintained only when node wishes to transmit the information from source to destination. AODV is combination of DSR and DSDV routing algorithm. It uses the route discovery mechanism of DSR routing algorithm. The difference is DSR transmits packets which consist of complete path and data from source to destination when a route is discovered, where AODV uses next hop information to transmit data from source to destination i.e.in AODV routing protocol network overhead is reduced when compared with DSR. AODV avoids the "counting to infinity" problem by using destination sequence numbers, the same mechanism used in DSDV algorithm. This makes AODV loop free. AODV uses two types of messages to establish a route from source to destination: - Route Requests (RREQs): This message used to start the route finding process, Route Replies (RREPs): this message used to conclude the routes, and Route Errors (RERRs): This message used to alert the network of a link break in an active route. Figure 3 shows the AODV routing mechanism.

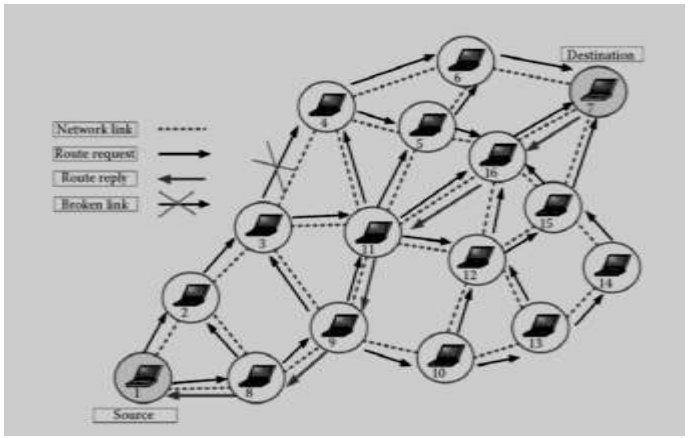
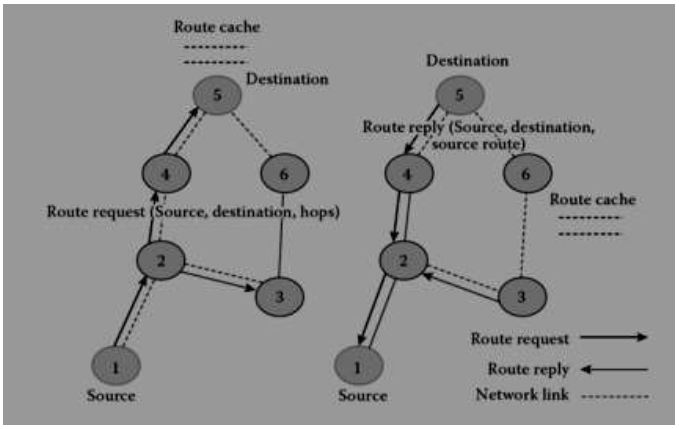


Fig.3 AODV routing mechanism

ii) Dynamic Source Routing Protocol: DSR is an on-demand routing protocol designed to overcome the problem of proactive routing protocols, where each node maintains the full network topology in the table form and its get updated periodically which reduces the use of network bandwidth. In DSR route is established only when a node wishes to transmit a packet from source to destination. It means DSR does not use any periodic routing advertisement, link status sensing, or neighbor detection packets. The key characteristic of DSR is the use of source routing. The source node knows the complete hop-by-hop route to the destination, and these routes are stored in a route cache. DSR protocol uses two mechanisms that work collectively to allow the discovery and maintenance of source routes in the ad hoc network: The first is route discovery, which is accomplished by flooding RREQ packet in the network. When RREQ packet reaches to the intended destination node, then it responds by sending RREP packet back to the source along the same route traversed by the incoming RREQ packet. The second is route maintenance. If any link broken on a source route, the source node is informed through RERR (Route Error) packet. The broken link is removed from source cache. A new route detection process is initiated by the source only if this route is still required. The advantage of DSR protocol is route cache by source, which decreases overhead on route maintenance. The disadvantage of DSR routing is that packet header size grows proportional to the network size. Figure 4 shows DSR routing mechanism.



iii) Temporally-Ordered Routing Algorithm (TORA): Temporarily ordered routing algorithm (TORA) is highly adaptive, loop-free, and distributed routing algorithm. It is based on the concept of link reversal. It uses directed acyclic graphs (DAG) to determine the routes either as upstream or downstream. This DAG graph empowers TORA to provide better route assistance for networks with dense, large population of nodes [11]. Anyhow to provide this feature TORA synchronize the nodes which limits the application of the protocol. TORA also operates in a highly dynamic mobile networking environment. TORA is a moderately complicated protocol but propagation of control messages only around the point of failure when a link failure occurs. This makes it unique and prominent feature. In comparison, all the other protocols require to re-initiate a route discovery when a link fails but TORA would be able to patch itself up around the point of failure. This feature allows TORA to scale up to larger networks but has higher overhead for smaller networks. TORA performs four major functions: creating, maintaining, erasing and optimizing routes. Since every node must have a height, any node which does not have a height is considered as an erased node and its height is considered as null. Sometimes the nodes are given new heights to improve the linking

structure. This function is called optimization of routes. Table 2 shows the comparison of reactive routing protocols.

TABLE 2: COMPARISON OF REACTIVE ROUTING PROTOCOLS

Parameters	AODV	DSR	TORA
Route Creation	By source	By source	Locally
Periodic updation	No	No	No
Performance Metrics	Speed	Shortness	Speed
Routing overhead	High	High	High
Caching overhead	Low	High	Medium
Throughput	High	Low	Low
Multipath	No	Yes	Yes
Route updation	Non-periodic	Non-periodic	High routing overhead

VI. CONCLUSION:

In this paper, we presented and discussed the two routing protocols of mobile ad hoc network and also provided comparisons between them. For each of these categories, we reviewed and compared certain representative protocols. There are many challenges facing mobile ad hoc networks related to routing, security and scalability. Based on the type of network, we have to select a suitable routing protocol. The important factor that differentiates between the routing protocols is the ways of discovering and maintaining the routes between the source and destination pairs. The comparison presented in this paper between the routing protocols illustrates that develop of secure and QoS routing protocols establish a challenging research against the existing solutions. Finally we expect provided the comprehensive characteristic features of two routing protocols and represented which protocols may behave best in large networks. Still mobile ad hoc networks have mannered a great challenge for the researchers because of changing topology and security attacks.

REFERENCES

[1] P. Papadimitratos and Z. J. Haas. "Secure routing for mobile ad hoc networks," "*SCS Communication Networks and Distributed Systems Modeling and Simulation Conference* (CNDS 2002)", Jan 2002.

[2] M. Zapata, N. Asokan, "*Securing ad hoc routing protocols*", WiSe'02, ACM 1-5813-585-8, September 28, 2002, pp.1-10.

[3]. E. M. Royer and Chai-Keong Toh, "*A Review of Current Routing Protocols for Ad Hoc Mobile Wireless Networks*".

[4] C. E. Perkins and P. Bhagwat, "Highly Dynamic Destination-Sequenced Distance-Vector (DSDV) for Mobile Computers," "*Proc. ACM Conf. Communications Architectures and Protocols"*, London, UK, August 1994, pp. 234-244.

[5] T. H. Clausen et al., "The Optimized Link-State Routing Protocol. Evaluation through Experiments and Simulation," "*Proc. IEEE Symp. Wireless Personal Mobile Communications 2001*", Sept. 2001.

[6]. S. Murthy, C. Siva Ram and B.S. Manoj, "*Ad Hoc Wireless Networks: Architectures and Protocols*," Prentice Hall, Chapter 7, 2004

[7] G. Pei, M. Gerla, T.-W. Chen, "Fisheye state routing in mobile ad hoc networks," in: "*Proceedings of IEEE ICDCS Workshop on Wireless Networks and Mobile Computing"*, April 2000, pp. D71–D78.

[8] D. B. Johnson, D. A Maltz, and J. Broch, "DSR: The Dynamic Source Routing Protocol for Multi-Hop Wireless Ad hoc Networks," "*Ad Hoc Networking, C.E. Perkins"*, Ed., Addison-Wesley, 2001, 139-172.

[9] C. E Perkins, E. M. Royer, and S. Das, "*Ad hoc On-demand Distance Vector (AODV)*," RFC 3561, July 2003.

[10] P. Papadimitratos and Z. J. Haas. "Secure routing: Secure Data Transmission in Mobile Ad Hoc Networks," "*Proc. ACM Wksp. Wireless Security 2003"*, Sept. 2003, pp. 41-50.

[11]A. K. Gupta, H. Sadawarti, and A. K. Verma, "Performance analysis of AODV, DSR & TORA Routing Protocols," "*IACSIT International Journal of Engineering and Technology*", vol.2, vo.2, April 2010.

